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(71) Applicant *(for all designated States except US):* BENCERE LTD. [GB/GB]; Brewery Lane, Hook Norton, Banbury, Oxfordshire OX15 5NX (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* RYE, Martin, Cee [GB/GB]; Brewery Lane, Hook Norton, Oxfordshire OX15 5NX (GB).

(74) Agent: STANLEY, Michael, Gordon; 86 Warwick Road, Banbury, Oxfordshire OX16 7AJ (GB).

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(54) Title: GAUGE DEVICE

(57) Abstract

A gauge (10, 110) for determining when an object, e.g. a cutting tool, is a predetermined distance (D) from a surface e.g. a machine tool surface. The gauge has a body (11, 111) having a datum base surface (41) for placing against said surface and a probe (16, 116) mounted in the body for axial movement and which has a contact surface (18, 118) for contact with the tool. An electrical ciurcuit (C1 C2, C3 C4 C5) arranged within the body includes an indicator (33, 133) and a battery (26, 126) which are connected so that the indicator is operably connected internally of the body with the battery by the probe (16, 116) when the contact surface (18, 118) is a known distance (D) from the datum surface (41). The gauge is a self contained unit which does not use the machine tool as part of its electrical circuit.

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GAUGE DEVICE

This invention relates to gauges for determining when an object is a predetermined distance from a surface, and more particularly it relates to tool pre-setting devices for setting cutting tools on machine tools such as mills, lathes, turning centres, machining centres, rotary and line transfer machines, robotics and other applications.

There are prior art machine tool setting gauges in which a probe having a contact surface is resiliently mounted in a base, the gauge further including a battery and a lamp such that one pole of the battery earths through the base and the machine tool, and the other pole of the battery is connected to the probe so that the contact of the cutting tool against the probe completes the electrical circuit throught the cutting tool and the machine tool and the lamp is switched on. Such devices are shown in US 3553671 and WO 86/05737.

Other similar devices operate with electrically inducted current flowing around the machine tool and through the cutting tool.

However, all these devices suffer from the disadvantage that they do not operate with non-conductive cutting

tools. Further in the event of an electrical resistance in the machine, caused by for example, non-conductive slideway surfaces, dirt, or oil film, etc., where high resistance is encountered the voltage supply to the setting gauge has to be greatly increased to cause the lamp to illuminate.

Similarly the lamp will not operate if the cutting tool is held in a holder which rotates within nylon bearings, or other electrically non-conductive materials, or the spindle is insulated from the rest of the machine.

Yet another disadvantage of the prior art systems is that they can be activated by very small droplets of cutting fluid or water, such as might be caused by condensation, on the tips of a tool so that the conductive liquid completes the electrical circuit rather than direct tool contact.

The invention provides a gauge which overcomes the above difficulties.

Accordingly there is provided a gauge for determining when an object is a predetermined distance from a surface, and which comprises a body having a datum base surface for placing against said surface; a probe mounted in the body for axial movement relative thereto, and

which has a contact surface for contact with said object; an electrical circuit arranged within the body and including an indicator means and a voltage source which are connected so that the indicator means is operably connected internally of the body with the voltage source, by the probe when the contact surface of the probe is a known distance from the datum surface.

Preferably the voltage source is a battery having one pole connected to a first electrical contact on the probe through the indicator means and its other pole connnected to a second electrical contact spaced from the first contact and having an operative position fixed relative to said body.

Conveniently, a portion of the probe is electrically conductive and serves to operably connect the indicator means and the voltage source when the contact surface is at said known distance.

Said other pole may be connected to an earth formed by the body of the gauge , or alternatively, said other pole is connected to an contact button forming the second electrical contact . When the two contacts meet they close the electrical circuit.

The battery may be housed in a holder of electrically

non-conductive material having the contact located button at one end thereof, and said one pole of the battery is connected to the indicator means, preferably an LED , via a conductive cap which holds the battery in place.

The known distance at which the LED lights is determined by the addition of two independant dimensions, the distance between the contact surface on the probe and the first electrical contact, and the distance between the datum base surface and the second electrical contact.

The invention will be described by way of example and with reference to the accompanying drawings in which:

Fig 1 is a longitudinal cross-section through a first gauge according to this invention with a schematic of the electrical circuit shown on the drawing,

Fig 2 is similar cross-section through a second gauge also according to this invention,

Fig 3 is a corss-section through a detail of Fig 2 showing a further modification.

Now with reference to the drawing, there is illustrated a gauge device 10 for determining when an object is a predetermined distance from a surface. This would normally be to pre-set a machine tool tip a known

distance from a work piece surface or other datum, so that its co-ordinates can be fed into a numerical control system.

The gauge has a cylindrical body 11 comprising a lower base 12 and an upper cap 13. The base 12 is made from an electrically conductive material and has a coaxial bore 14 therein.

The cap 13 is made of an electrically insulating material, for example, nylon, phenolic resin compounds or other suitable materials and also has a coaxial stepped bore 15 therein having a smaller diameter portion 15A uppermost and larger diameter portion 15B which opens into the bore 14 in the abutting base 12. The bore 14 in the base has a larger diameter than the larger diameter portion 15B of the bore 15 in the cap.

A probe 16, in the form of a stepped piston is mounted in the cap 13 of the body 11, and is axially slideable in the stepped bore 15. The piston 16 comprises a larger diameter head portion 19, and a smaller diameter coaxial stem portion 17 which is electrically insulated from the head portion 19 by an insulator sleeve 39. The stem portion 17 slides in the smaller diameter portion 15A of the stepped bore and has an upper end contact surface 18 for contact with a cutting tool tip, and the head portion

19 is slideable in the large diameter portion 15B of the stepped bore 15. Upward movement of the piston 16 is limited by abutment of the head portion 19 against the shoulder 20 between the two different diameter portions 15A, 15B of the stepped bore 15. The axially inner portion of the probe 16, ie. the head 19, is electrically conductive.

The bore 14 in the base 12 has its bottom end closed by a power source holder 22 which comprises a cylindrical head portion 23 which closes the bore 14 and an axially inwardly projecting smaller diameter coaxial spigot 24. An inwardly extending coaxial blind bore 25 is formed in the holder 22 and extends into the spigot 24. This serves to house a voltage or EMF source 26 e.g. a battery, and has its axially outer end closed by a screw cap 27. The holder 22 and screw cap 27 are both made of an electrically conductvie material.

Located in the bore 14, between the holder 22 and the cap 13 is a cylindrical contact member 28 which is in the form of an inverted cup shaped plunger and which is made from an electrically conductive material. The contact member 28 is slideable in the bore 14 and is mounted over the spigot 24 which extends into the contact member 28. A resilient means, in the form of a compression spring 29 is fitted over the spigot 24 and serves to bias the

contact member 28 upwardly into an operative position. The upward movement of the contact member 28 is limited by abutment with the cap 13. A wear plate 31 may be inserted into the cap to prevent the contact member 28 from gradually wearing away the insulating cap 13 and causing inaccuracies in the gauge.

A second resilient means, spring 32, of a lower stiffness value than the spring 29, acts between the contact member 28 and the probe 16 to bias the probe axially upwardly until the head 19 of the probe abuts the shoulder 20. The spring 32 is of an electrically conductive material.

On the upper external surface of the cap 13, there is located an indicator means 33 which is preferably a light emitting diode (LED) lamp, but could be other suitable means such as a sound emmitter, a radio signal transmitter, or other indicative signal generators. The LED lamp 33 is connected by a first electrical cirucit C1 to a contact 34 which is directly in contact with one pole of the battery 26. The contact 34 is insulated from the power source holder 22 by an insulator ring 35. The LED 33 is also connected by a second electrical circuit C2 to a second contact 36 which is housed coaxially in the upper surface of the contact member 28. The contact 36 is isolated from the contact member 28 by a second insulator ring 37 but is electrically connected to the

probe head 19 which constitutes a first electrical contact.

The probe 16 may have a hardened insert 38 in its outer contact surface 18 to prevent wear and damage to the surface. The contact surface 18 is electrically insulated from the head portion 19 of the probe 16 by the sleeve 39 to prevent reverse electrical contact through the machine and cutting tool.

The base 12 has a bottom datum surface 41, which may have magnetic inserts 40 therein for holding the gauge to a working ferrous metal surface such as a machine bed or other working datum surface.

The battery 26 has one pole earthed to base 12 of the body of the gauge via the screw cap 27,and holder 22. The cap 27 , holder 22 , base 12 and contact member 28 are therefore all at the same electrical potential. The contact member 28 constitutes a second electrical contact which co-operates with the first contact formed by the probe head 19 . The other pole of the battery 26 is connected throught the electrical circuit C1, LED lamp 33, electrical circuit C2, and spring 32, to the head 19 of the probe 16. The head 19 , at the electrical potential of said other pole of the battery, is isolated from earth by the non-conductive cap 13 and sleeve 39.

When the tip of a cutting tool is brought into contact with the contact surface 18 of the probe 16 and causes the probe to move axially inwardly, the LED lamp 33 will light up when the head portion 19 of the probe contacts the uppermost surface of the contact member 28 and completes the electrical circuit. The linear dimension D at which point the lamp 33 illuminates is predetermined and its co-ordinates can be entered into the controls of a numerically controled machine tool, or into the offset registers within other programmable devices, to preset the cutting tool.

If the machine tool tip overtravels, the contact member 28 can move axially downwardly against the bias of the spring 29 to absorb the overtravel and thereby prevent damage to the cutting tool, machine, or the gauge.

When the gauge is mounted onto a machine, or datum surface, the base 12 will make electrical contact with the machine working surface assuming that it is say steel and of course it will be at the same potential as the base 12. Therefore, in certain circumstances, a reverse electrical circuit may be set up throught the machine to the tool tip. The insulator sleeve 39 acts to prevent the LED lamp 33 from lighting on contact of the cutting tool with the probe contact surface 18.

The guage is a self contained unit which does not rely on external electrical circuits set up through machine tools, or an external power source.

The probe 16 could have a screw adjustable insert (not shown) to allow the gauge to be selectively set for different known distances.

Now with reference to Fig 2, there is illustrated a gauge device 110 which is similar to that illustrated in Fig 1. The gauge 110 has a body 111 comprising a base 112 and a cap 113. The base 112 is formed from a magnetizable material, for example mild steel, and has a coaxial bore 114 therein.

The cap 113 is made of an electrically insulating material as before, and also has a coaxial stepped bore 115 therein having a smaller diameter portion 115A uppermost and larger diameter portion 115B which opens into the bore 114 in the base. The smaller diameter portion is lined with an electrically conductive bush 139, preferably a brass bush. The bore 114 in the base has a larger diameter than the larger diameter portion 115B of the bore 115 in the cap 113.

The probe or piston 116, is a stepped piston mounted in the bush 139 in the cap 113, and is axially slideable in

the stepped bore 115. The piston 116 has a smaller diameter coaxial hollow stem 117 which extends through the smaller diameter portion 115A of the stepped bore and has an upper end contact surface 118 for contact with a machine tool tip, and larger diameter head 119 fixed into the hollow stem and which is slideable in the large diameter portion 115B of the stepped bore 115. The head 119 is made of electrically conductive material. Upward movement of the piston 116 is limited by abutment of the head 119 against the shoulder 120 between the two different diameter portions of the stepped bore 115.

Also located in the hollow stem 117 of the piston 116 is an electrically conductive contact 136 forming the first electrical contact and which is biased downwards by a spring 141. The contact 136 projects through a bore 137 in the center of the head 119 and has a shoulder 138 which limits its downwards movements.

The bore 114 in the base 112 houses a power source holder 122 which unlike the previous embodiment is made from an electrically insulating material. The holder 122 has a radially outwardly projecting flange 123 on its outer surface, which locates between a flange 121 on the base 122 and the cap 113. A coaxial bore 125 is formed in the holder 122 which houses a power source 126 e.g. a battery, and has its axially outer end closed by an

electrically conductive screw cap 127 and its inner end closed by an electrically conductive contact button 128 forming the second electrical contact. The spring 129 makes an electrical connection between a pole of the battery 126 and the contact button 128.

A resilient means, in the form of a compression spring 132 is housed in the bore 115, and acts between the holder 122 and the piston 116 to bias the piston 116 upwardly until the head 119 abuts the shoulder 120.

On the upper external surface of the cap 113, there is located an LED indicator means 133 as previously described.

The LED 133 is connected by a first electrical wire C3 to an annular conductive plate 134 such as a brass plate fitted to the flange 123 of the holder 122. The connection between the wire C3 in the cap and the plate 134 is made through a spring 135. The plate 134 is connected by a wire C4 to the screw cap 127 and hence to one pole of the battery 126. The LED 133 is also connected by an electrical wire C5 to the bush 139 and then via the piston 116, head 119, spring 141 to the contact 136 so that the contact 136 is at the same potential as the screw cap 127. The other pole of the

battery is connected via spring 129 to the contact button 128.

The bottom datum surface 41 on the base 112 has magnetic inserts 40 therein for holding the gauge to a machine bed. In this embodiment, the magnetic inserts 40 are recessed into the base.

When the tip of a tool is brought into contact with the upper surface 118 of the probe 116 and causes the probe to move axially inwardly the LED lamp 133 will light up when the contact 136 the uppermost surface of the contact button 128 and completes the electrical circuit. The linear dimension D at which point the lamp 133 illuminates is predetermined and its co-ordinates can feed into the controls of a numerically controlled machine tool to present the cutting tool. The distance D is detèrmined by a simple addition of the two independant distances D1 and D2. D1 is the distance between the contact surface 118 and the end of the contact 136 in its most downward position, and D2 is the distance between the datum base surface 41 and the upper surface of the contact button 128. Hence any tolerances related to dimensions of the cap 113 and base 112 can be absorbed.

If desired, the two dimensions D1 and D2 can be predetermined to sum to for example 50 mm. In this case

the datum surface 41 base 112 can be machined down until the LED lights up at the desired 50 mm dimension.

If the machine tool tip overtravels, the contact 136 can move axially upwardly against the bias of the spring 141 to absorb the overtravel and thereby prevent damage.

In a further embodiment of the invention, a screw adjustable electrically conductive contact pad 150 can be mounted in the contact button 128 so that the probe 116 can be moved inwardly until the upper surface 118 and the datum surface 41 are a known distance apart e.g. 50 mm and the contact pad 150 is adjusted by screwing axially in or out until the LED just lights. To perform this operation the battery 126 is removed and power is fed into the gauge by a plug in device that allows access to the contact pad.

CLAIMS

1. A gauge for determining when an object is a predetermined distance from a surface, and which comprises a body having a datum base surface for placing against said surface, a probe mounted in the body for axial movement relative thereto, and which has a contact surface for contact with said object, an electrical circuit arranged within the body and including an indicator means and a voltage source which are connected so that the indicator means is operably connected internally of the body with the voltage source by the probe, when the contact surface of the probe is a known distance from the datum surface.

2. A gauge as claimed in Claim 1 wherein the voltage source has one pole connected to a first electrical contact on the probe through the indicator means, and its other pole connected to a second electrical contact spaced from the first contact and having an operative position fixed relative to the body.

3. A gauge as claimed in Claim 1 or Claim 2 wherein said body comprises a base having a bore therein, an insulating coaxial cap at the upper end of the base in which the probe is axially slideably mounted, a first electrical contact on the probe being connected to one pole of the voltage source, and a contact member forming

a second electrical contract located in the bore of the base and which is connected to the other pole of the voltage source, said indicator means becoming operative when the two contacts meet.

4. A gauge as claimed in any one of Claims 1 to 3 wherein at least a portion of the probe is electrically conductive and said portion completes the electrical circuit between the indicator means and the voltage source when the contact surface is at said known distance.

5. A gauge as claimed in Claim 2 and Claims 3 or 4 when dependant upon Claim 2, wherein the two electrical contacts are biased apart by a first spring, and at least one of the electrical contacts is biased towards the other contact by a second spring so that the both contacts can move together relative to one of the piston and body after closing to prevent damage.

6. A gauge as claimed in Claim 3, and Claim 4 or Claim 5 when dependant upon Claim 3, wherein the voltage source is a battery held in a battery holder forming part of the base and located in the bore in the base with at least a portion of the battery holder forming part of the electrical circuit within the gauge.

7. A gauge as claimed in Claim 5 or Claim 6 wherein the voltage source is a battery and the second electrical contact connected to said other pole is electrically connected to an electrical earth formed by a portion of the body.

8. A gauge as claimed in Claim 7 wherein the probe is slideably mounted in the body and is insulated from said earth and an inner portion of the probe is electrically conductive and forms said first electrical contact, the inner surface of the probe connecting to earth when the contact surface is at said known position.

9. A gauge as claimed in Claim 8 wherein said contact surface is insulated from the inner portion of the probe to prevent the indicator device and voltage source being externally connected between the probe and base.

10. A gauge as claimed in any one of Claims 7, 8, or 9, wherein the second electrical contact is resiliently biased towards the probe and cap by said second spring to be held in the opertative position spaced from the probe and electrically insulated therefrom, the second electrical contact being moveable against the resilient bias of the second spring in event of further axial movement of the probe after contact of the probe against said contact member.

11. A gauge as claimed in Claim 10 wherein said second electrical contact is an electrically conductive plunger slideable within the bore in the base, and biased away from the battery holder by said second spring.

12. A gauge as claimed in any one of Claims 7 to 11 when dependant upon Claim 6, wherein the battery holder is electrically conductive and is in contact with the base such that the base, holder and second electrical contact are all connected to form an earth for said other pole of the battery, said one pole of the battery being insulated from earth and being connected to the first contact, the probe being resiliently biased away from the second electrical contact by the first spring which is also electrically conductive and which connects first contact on the probe with said one pole of the battery.

13. A gauge as claimed in Claim 5 or Claim 6 wherein the voltage source is a battery and is held in a battery holder made of a non conductive material and the battery holder has an electrically conductive cap which holds the battery in place and contacts one pole of the battery and is connected to the first electrical contact on the probe via the indicator means, and an electrical contact button is located at the other end of the battery holder and is connected to the other pole of the battery to form the second electrical contact.

14. A gauge as claimed in Claim 13 wherein the whole probe is electrically conductive and is hollow with the first electrical contact slideably located within the hollow plunger and biased to its operative position by the second spring also located within the hollow probe.

15. A gauge as claimed in any one of Claims 2 to 14 wherein the known distance at which the indicator means operates is derived from two independant dimensions.

16. A gauge as claimed in Claim 15 wherein the two independant dimensions are the distance between the contact surface on the probe and the first electrical contact on the probe, and the distance between the datum surface and the second electrical contact when in its operative position.

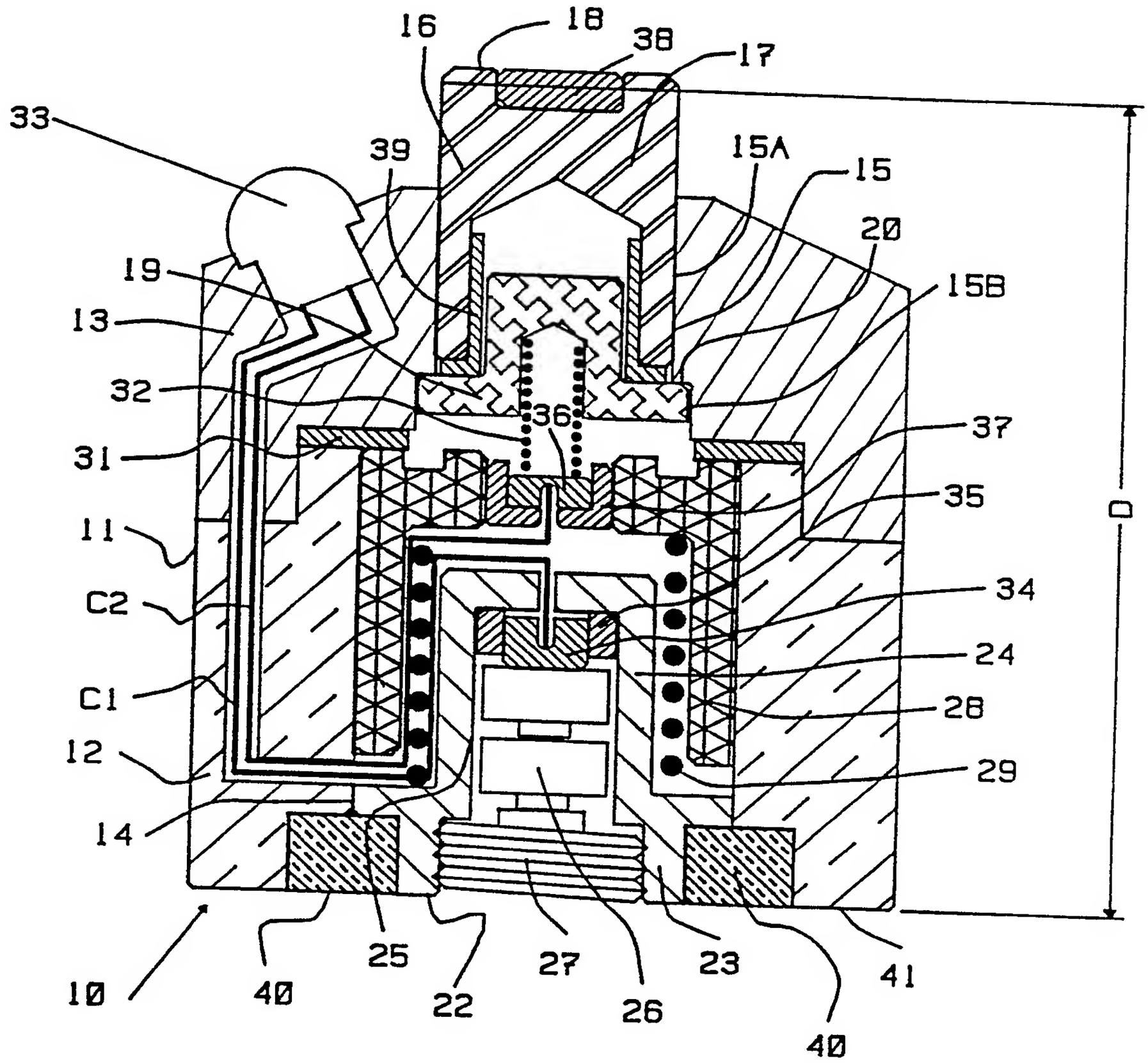
17. A gauge as claimed in any one of Claims 1 to 16 wherein the gauge has an adjuster means to selectively preset the gauge so that the indicator means operates at a predetermined known distance which is variable through the adjuster means.

18. A gauge as claimed in Claim 17 when dependant upon Claim 13, wherein the contact button has a screw threaded contact pad therein that can be selectively adjusted to cause the indicator means to operate when the two

dimensions are summed to a predetermined value.

19. A guage as claimed in any one of Claims 1 to 18 wherein the indicator means is a light emitting, audible or radio frequency transmitting device.

20. A guage as claimed in any one of Claims 1 to 19 wherein magnets are inserted into the datum base surface of the body to hold the gauge against a machine work surface of ferrous metal.


16
18
38
17
33
39
15A
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19
15B
13
32
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31
35
11
34
C2
24
C1
28
12
29
14
D
10
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41
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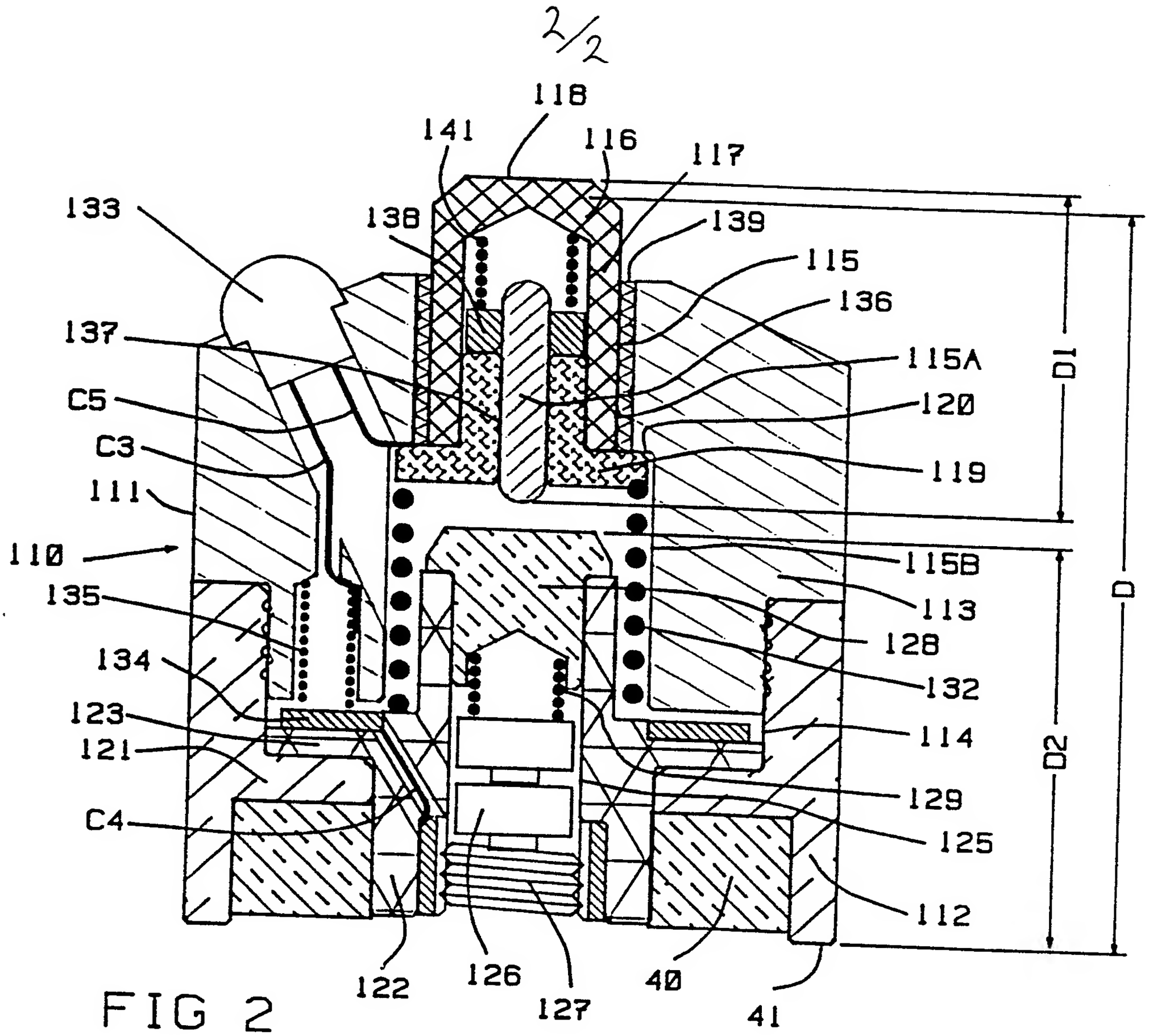
FIG. 1


118
141
116
117
133
138
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137
115A
C5
120
C3
119
111
110
115B
135
113
128
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121
129
C4
125
112
122
126
127
40
41
D1
D2
D

FIG 2

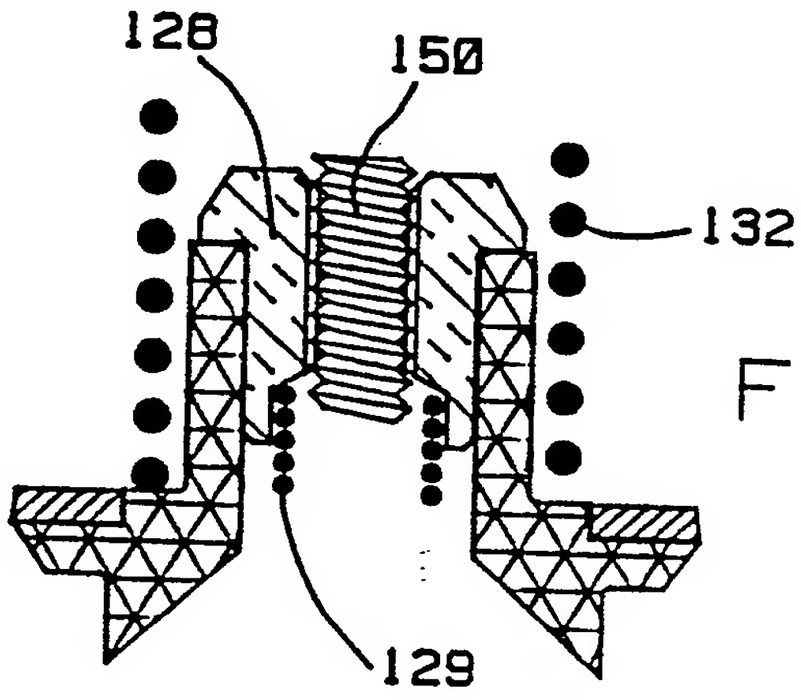
128
150
132
129

FIG 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/00298

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: B 23 Q 17/22, G 01 B 7/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	G 01 B 7/00, B 23 Q 17/00

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	WO, A, 86/05735 (INDUSTRIVERKTYG AB) 9 October 1986 see the whole document (cited in the application)	1,2,4-7,10, 12,15-17,19
	--	
Y	EP, A, 0225666 (OCE-NEDERLAND B.V.) 16 June 1987 see the whole document	1,2,4-7,10, 12,15-17,19
	--	
X	GB, A, 589364 (KAPELLA LTD) 18 June 1947 see page 3, line 5 - page 4, line 99; figures 1-3	1,2,4,15,16, 19
	--	
A	US, A, 3553671 (W.J. HOPKINS) 5 January 1971 see the whole document, especially figures 3,4; column 2, lines 10-15; column 3, lines 2-32, lines 60-62; ./.	1,2,4,6,11, 13-19

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14th June 1990	16 JUIL. 1990
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MISS T. TAZELAAR

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	claims 4,5,6, (cited in the application) --	
A	DE, A, 3737471 (R.W. CADDELL) 19 May 1988 see the whole document --	1,3,11,15,16
A	EP, A, 0076865 (H. LETZEL) 20 April 1983 see the whole document --------	1,3,11,15,16

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9000298 SA 34817

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 06/07/90
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP-A- 0216890	08-04-87
		JP-T- 62502676	15-10-87
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		CH-A- 504934	31-03-71
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